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# Carbon Monoxide Poisoning at a Surface Coal Mine ...

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## A Case Study

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# Anatomy of the CO Poisoning

- Spatial Relationships
- CO Levels
- Chronology
- Blasting
- Geology
- Residential Entry Points

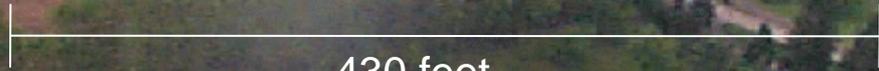
North



Highwall



430 feet



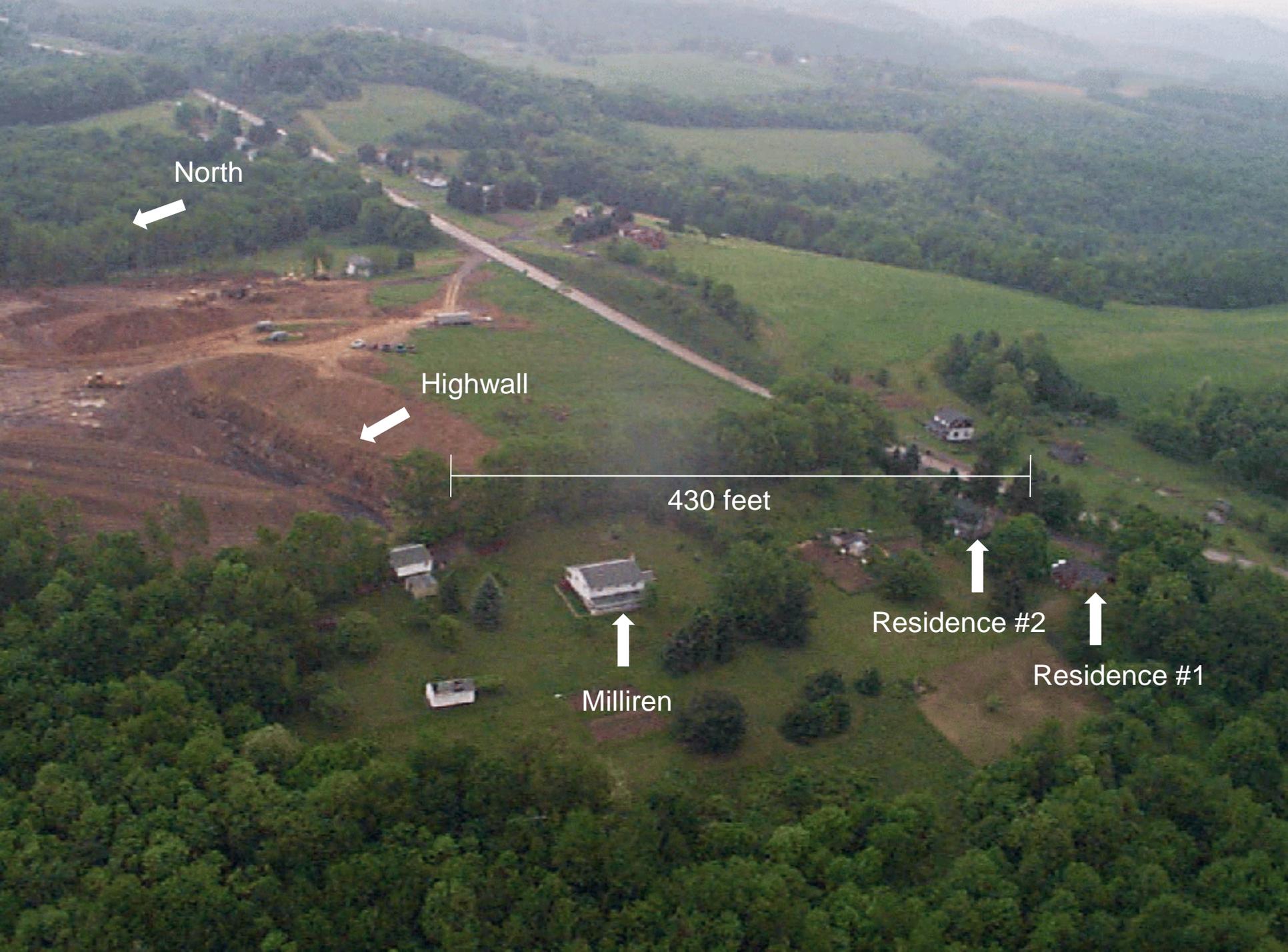
Milliren



Residence #2



Residence #1

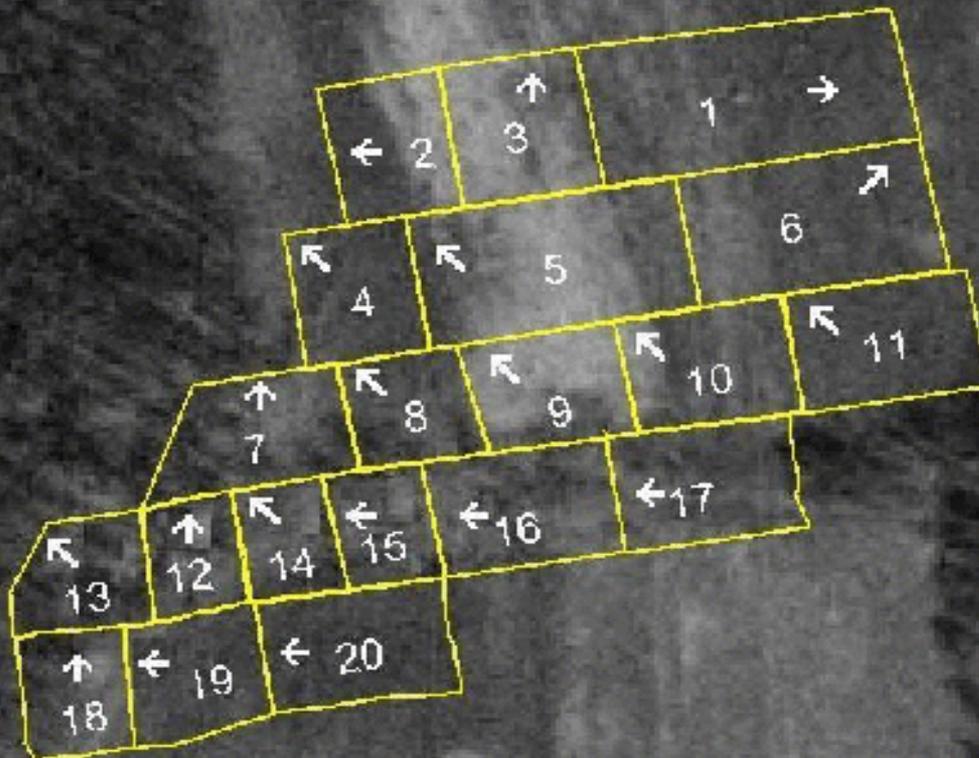


North



Garage

Milliren



Residence #1

Residence #2



3



2



1

Boreholes

4





Residence #1

Borehole #4

36" Well

# CO Poisoning — April 1, 2000

- Carboxyhemoglobin levels
  - ◆ Infant ----- 31 %
  - ◆ Husband ----- 28 %
  - ◆ Wife ----- 17 %

# Carboxyhemoglobin Levels

- 10% Asymptomatic or may have headaches
- 20% Dizziness, nausea, and syncope
- 30% Visual disturbances
- 40% Confusion and fainting
- 50% Seizures and coma
- 60% Cardiopulmonary dysfunction and death

# C0 Standards — Workplace

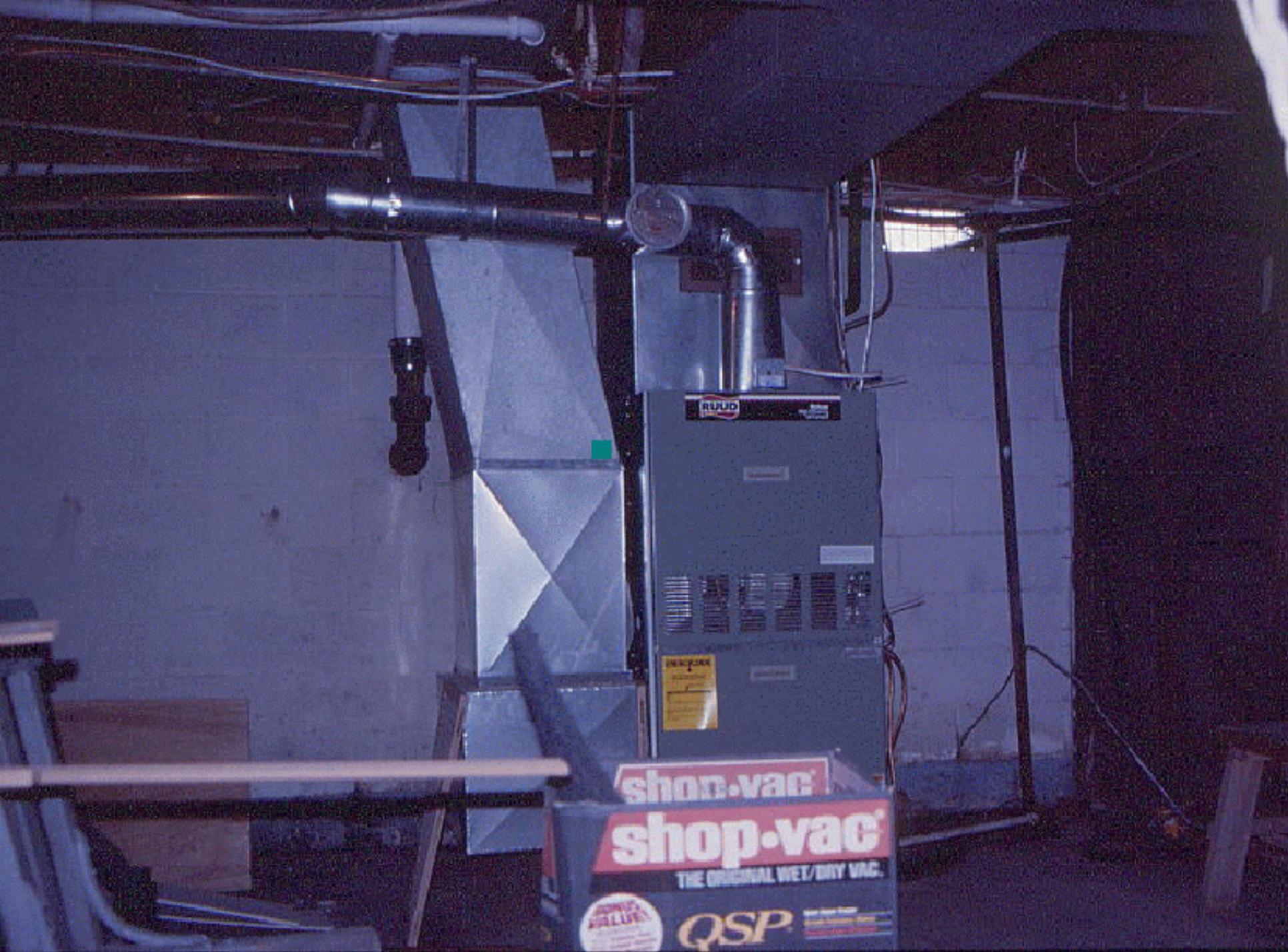
- **Immediately Dangerous to Life and Health (IDLH)**
  - ◆ 1,200 ppm (NIOSH)
  - ◆ 1,500 ppm (OSHA)
- **Short Term Exposure Limit (STEL) 15 Min.**
  - ◆ 200 ppm (NIOSH and OSHA)
- **Time Weighted Average (TWA) 8 Hours**
  - ◆ 50 ppm (OSHA)
  - ◆ 35 ppm (NIOSH)
  - ◆ 25 ppm (AIGIH)

# C0 Standards — Homeplace

- **Environmental Protection Agency (EPA)**
  - ◆ 25 ppm — 1 hour
  - ◆ 9 ppm — 8 hours
- **Consumer Product Safety Commission (CPSC)**
  - ◆ 25 ppm — 1 hour
  - ◆ 15 ppm — 8 hours

# Chronology

- February 2000 - mining began.
- March 7, 2000 - the first of twenty blasts.
- March 31, 2000 - two blasts are detonated in the afternoon.
- April 1, 2000 - in the early morning, later diagnosed with carbon monoxide poisoning.
- April 2, 2000 - the furnace contractor finds 650 ppm in a floor drain , 450 ppm on the first floor, and 400 ppm on the second floor.



RUUD

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THE ORIGINAL WET/DRY VAC.

WARRANTY

QSP

# Chronology

- April 2-7, 2000 - The family stays at their parents' home. Install two CO detectors.
- April 17, 2000 - two blasts are detonated (430 and 475 feet).
- April 20, 2000, one blast was detonated at 13:45. One hour later -73 ppm in the basement -46 ppm in the upstairs of the home.
- On April 21, 2000 - the DEP ER - 200 ppm in a floor drain - 160 ppm in the well. Note negative air pressure in floor drain.

# Chronology

- April 24, 2000 - DEP Blasting Inspector ceases blasting on the mine in the absence of a readily explainable source other than blasting.
- May 31, 2000 - DEP and OSM jointly conduct geologic profiling, find CO in the ground.
- July 7, 2000 - DEP writes an order for failure to prevent injury to people outside the permit area. States Industries decides to reclaim the site.

# Blasting and In-Pit Observations



## ANFO (3.4% FO)



## ANFO (5.5% FO)



## ANFO (8.0% FO)



# Blasting Fumes

1. Poor product formulation
2. Inadequate priming
3. Insufficient water resistance
4. Lack of confinement
5. Reactivity of the explosive with the rock
6. Incomplete product reaction.

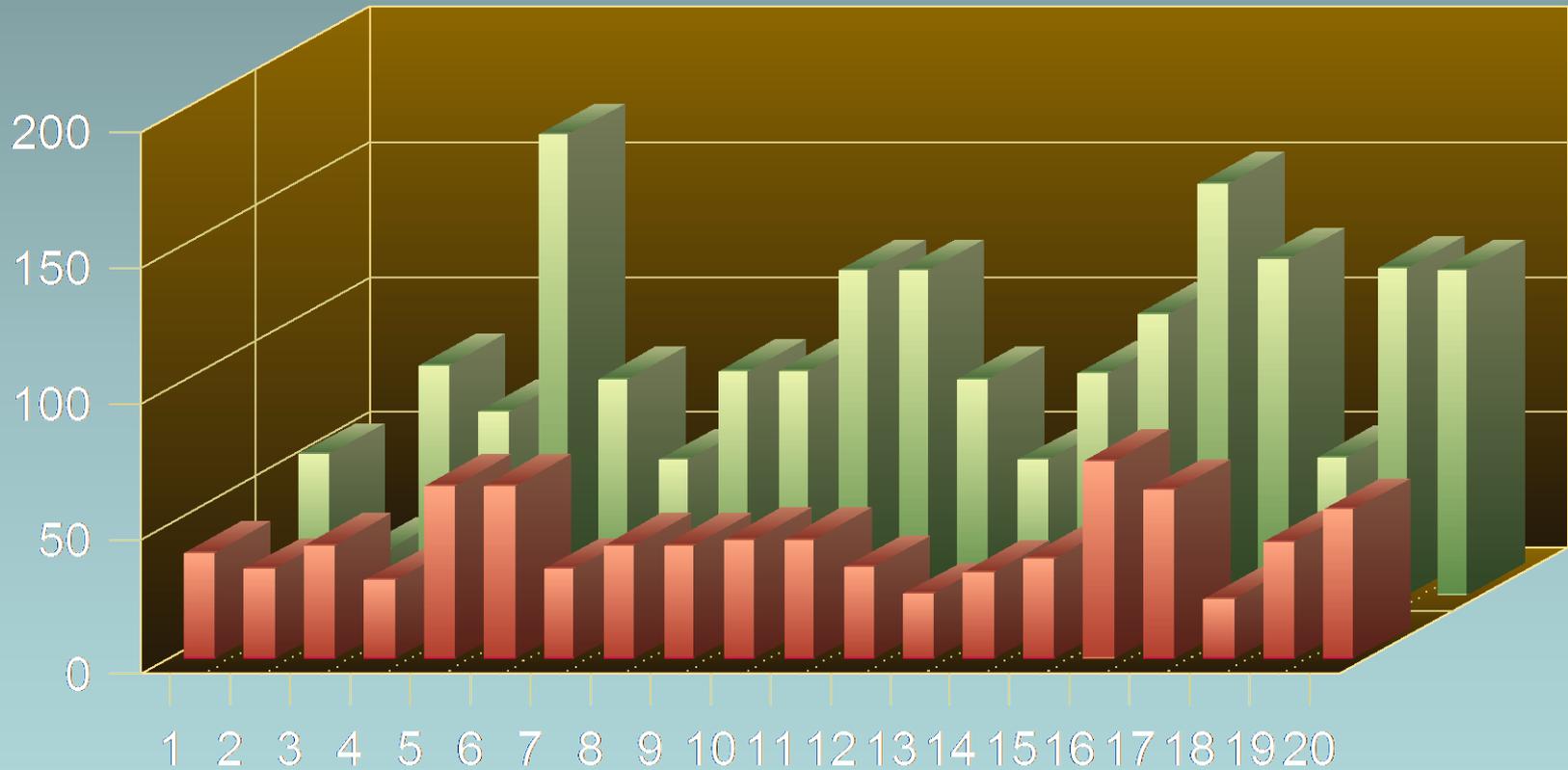
30' overburden, 6' sandstone 3' above coal



# Blast Design

- 16 to 89 holes
- 6 1/4 inches in diameter
- 16' X 16' pattern
- Powder column 1 1/2 to 15 feet
- ANFO with 1 lb booster
- Non-electric initiation
- Stemming 13 to 24 feet

# Blasting Data



Charge per Hole (lbs)



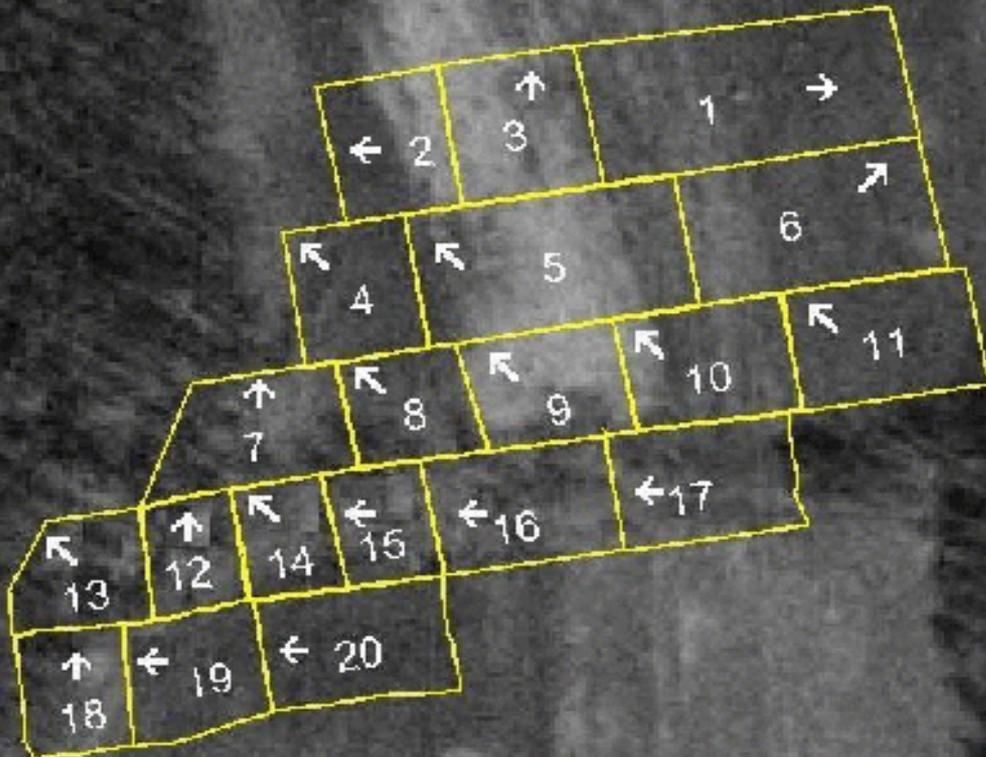
Powder Factor (lb/yd3 x 100)

North



Garage

Milliren



Residence #1

Residence #2



3

2

1

4

Boreholes







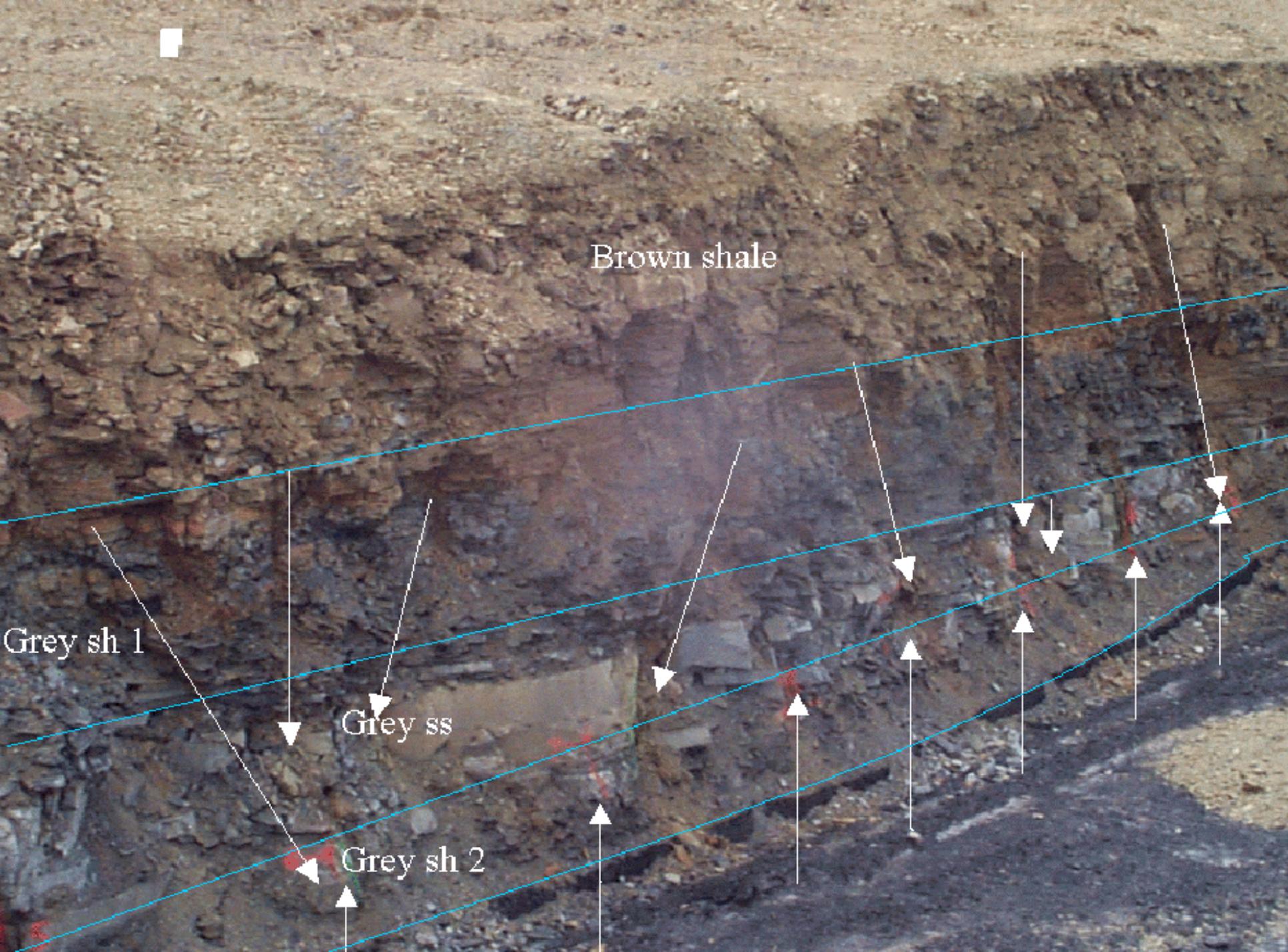


**Grey SH 1**

**Grey SS**

**Grey SH 2**

**U.F. Coal**



Brown shale

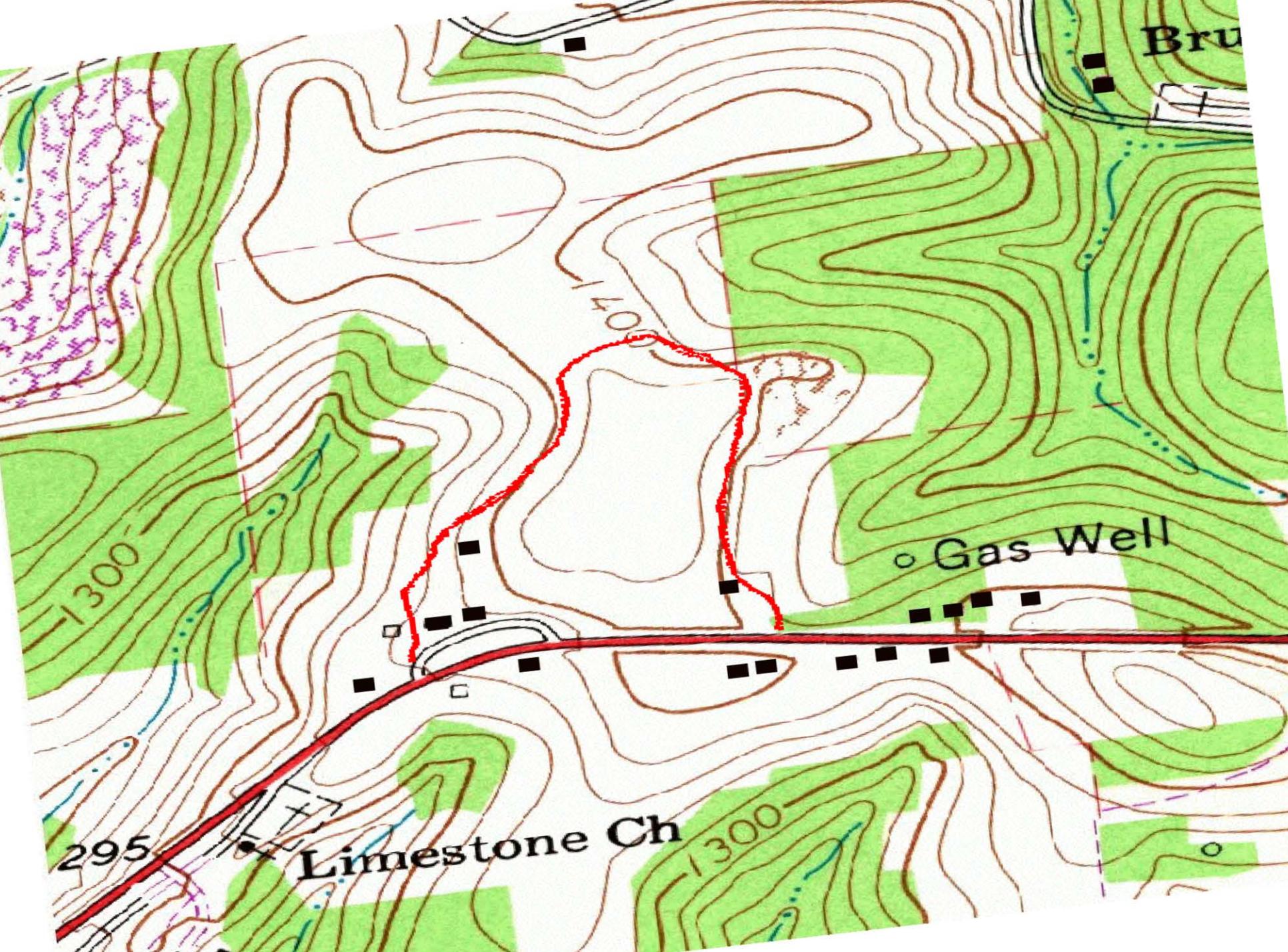
Grey sh 1

Grey ss

Grey sh 2

# Boreholes and Gas Sampling

- May 31, 2000
- Four holes
- Hole number 2 - 28 - 33 feet sandstone w/ 1' crevice



Br

1400

Gas Well

295

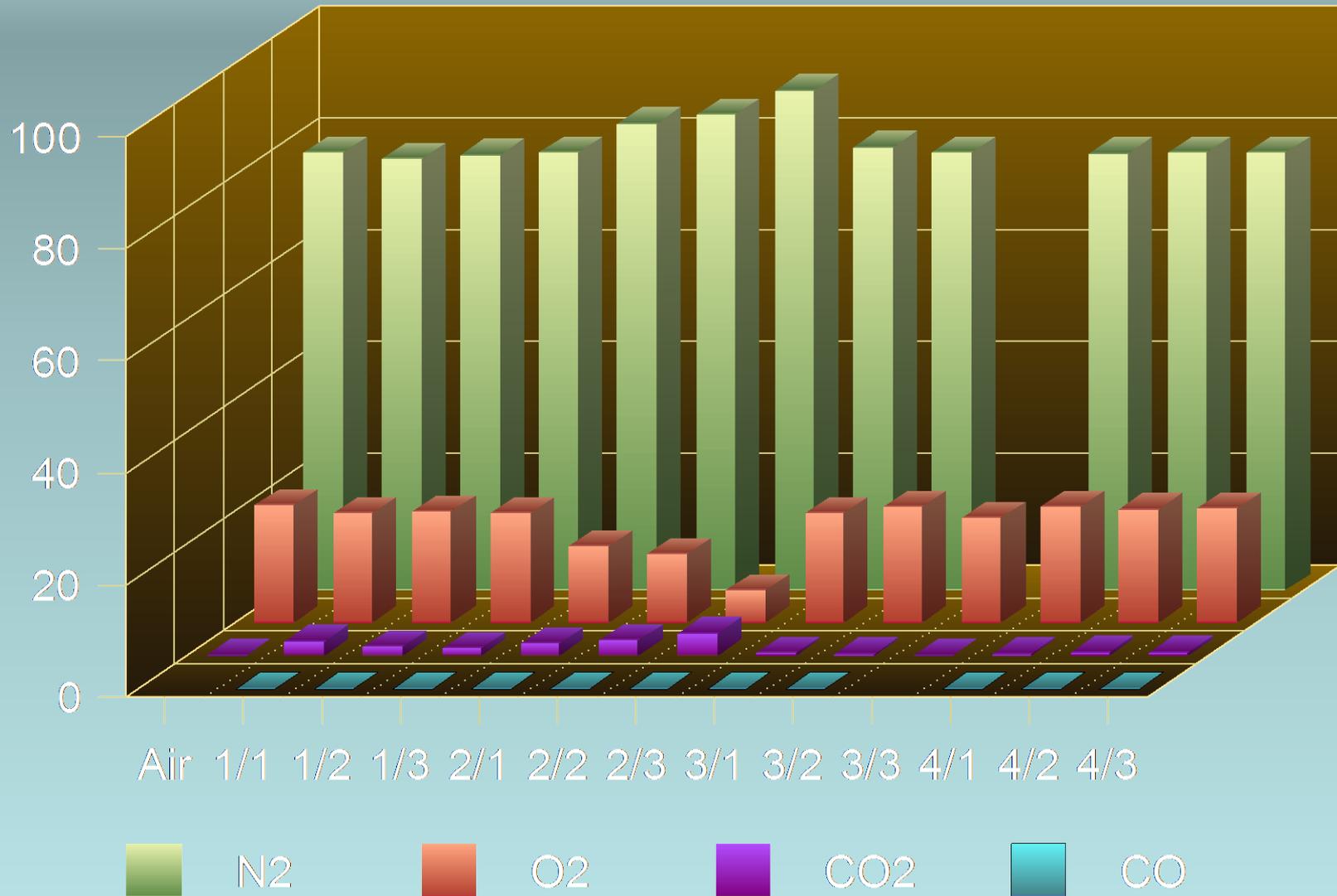
Limestone Ch

1300





# Borehole Gas Data





Residence #1

Borehole #4

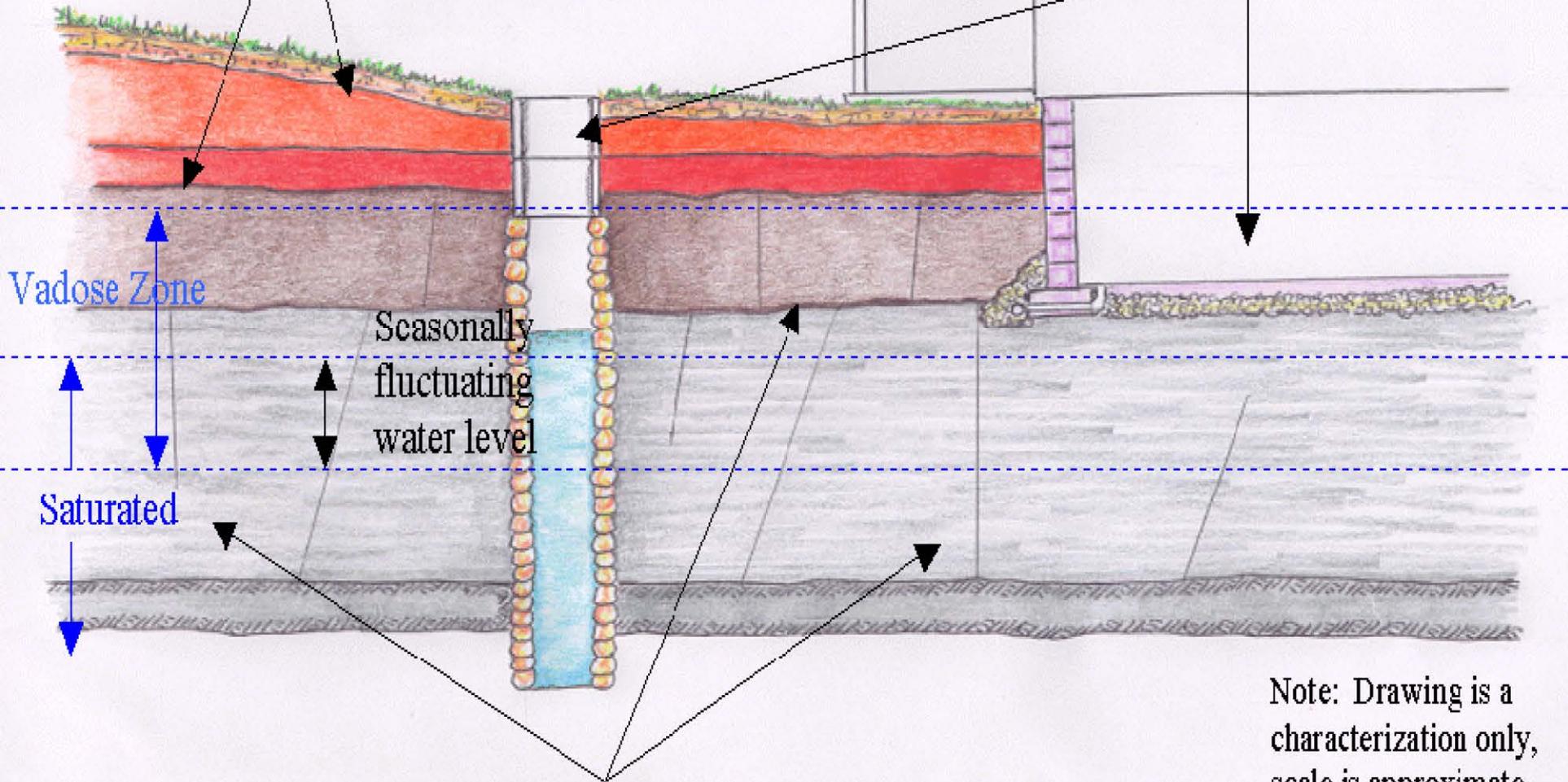
36" Well





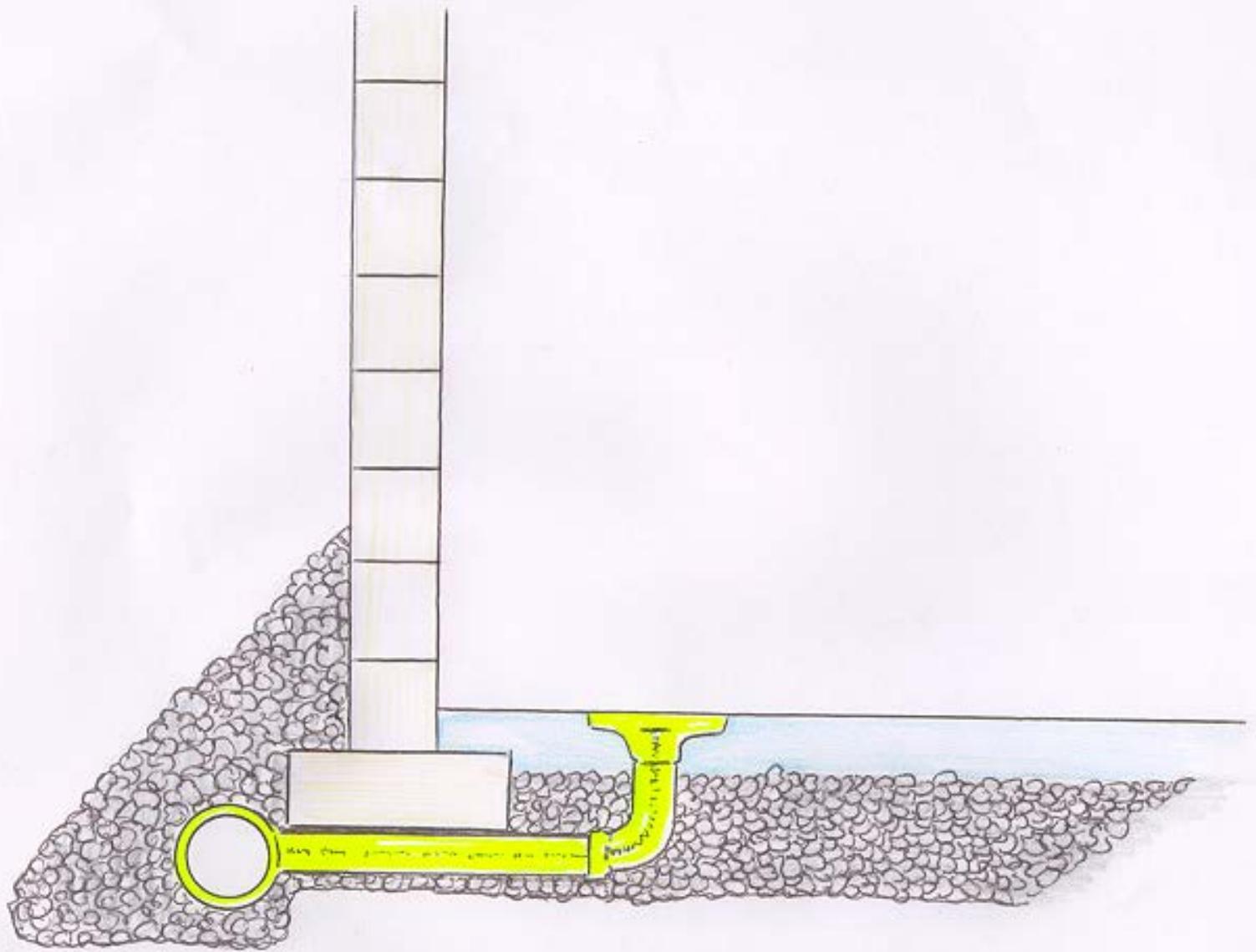
Cap rock and soil semi confining aquifer below

Affected House and Well



Note: Drawing is a characterization only, scale is approximate

Jointing in the gray shale and brown sandstone carrying water and fumes



# Conclusions

- Flyrock control - Primary focus of the blaster
- Inadvertently contained gases in the ground
- Blast holes were aligned with the fracture system
- Site geology provided a “pipeline and reservoir”
- A large diameter well collected the gases
- The french drain was openly connected to the floor drains
- ALL of these combined to cause the poisoning

# IME - Fumes from Blasting Operations

- Blasting was conducted to minimize displacement,
- Broken overburden was not immediately excavated,
- Carbon monoxide had a pathway to enter the basement, and
- Adequate or positive ventilation was not provided.

The only IME circumstance not existing at this site was that the blasts be “very close” to the residence.